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Army and Air Force Exchange Service (AAFES) Electrical Billing Analysis

by
Franklin H. Holcomb and Larry M. Windingland

The Army and Air Force Exchange Service (AAFES) operates and manages Army and Air Force exchange activities worldwide. Since electric utility use for AAFES and other activities is metered for kWh only (not actual kW demand), Directorate of Public Works (DPW) billings use an average consumption charge, which may over- or undercharge users. This study was undertaken to determine the impact if AAFES activities were billed for their actual electric consumption and demand rather than for an average consumption charge. Three AAFES facilities were monitored for electric consumption and demand during July, August, and September 1994.

In all three cases, the average consumption charge gave higher annual totals for electrical usage than charges based on separate consumption and demand. The study recommended that, before AAFES facilities incorporate utility style billing, installation DPWs should: (1) survey facilities to ensure that electrical meters are accurate, and (2) factor in additional costs associated with the change. Then, if the change is found to be warranted, meters capable of recording *both* kWh consumption and kW demand with automated data collection capabilities should be used to reduce the time required for meter reading and billing preparation.

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In all three cases, the average consumption charge gave higher annual totals for electrical usage than charges based on separate consumption and demand. The study recommended that, before AAFES facilities incorporate utility style billing, installation DPWs should: (1) survey facilities to ensure that electrical meters are accurate, and (2) factor in additional costs associated with the change. Then, if the change is found to be warranted, meters capable of recording both kWh consumption and kW demand with automated data collection capabilities should be used to reduce the time required for meter reading and billing preparation.

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Foreword

This study was conducted for Headquarters, Forces Command (HQFORSCOM) under Military Interdepartmental Purchase Request (MIPR) No. JE1592CERLENGY, dated 19 March 1992. The technical monitors were Pat C'debaca and Carl Johnson, AAFES-FS-E, and Adrian Gillespie, AFPI-ENO.

The work was performed by the Utilities Division (UL-U) of the Utilities and Industrial Operations Laboratory (UL), U.S. Army Construction Engineering Research Laboratories (USACERL). The USACERL principal investigator was Franklin H. Holcomb. Martin J. Savoie is Chief, CECER-UL-U; Dr. John T. Bandy is Operations Chief, CECER-UL; and Gary W. Schanche is Chief, CECER-UL. Pacific Northwest Laboratories (PNL), Richland, WA was contracted to do part of this work. The authors would like to thank Bobby Lynn, Albert McNamee, and Robert Kennedy of the Fort Hood Energy Office for providing historical kWh usage, Texas Utilities Electric rate structures, and other information for the Fort Hood PX test site. The authors would also like to thank Len May and Janice Pugh of the Fort Campbell DPW for providing historical kWh usage, TVA electric rate structures, and other information for the Fort Campbell PX and Shoppette test sites. Special thanks go to John Schmelzer and Rich Szydlowski of PNL for their valuable assistance in installing and removing the data collection equipment. The USACERL technical editor was William J. Wolfe, Technical Resources.

LTC James T. Scott is Commander and Director, and Dr. Michael J. O'Connor is Technical Director of USACERL.

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1.1 Background

The Army and Air Force Exchange Service (AAFES) operates, manages, and supervises Army and Air Force exchange activities worldwide. Army Regulation (AR) 60-10 defines AAFES' mission as:

1. Providing necessary and convenient merchandise and services to authorized patrons at uniformly low prices
2. Generating reasonable earnings to supplement appropriated funds for the support of Army and Air Force morale, welfare, and recreation (MWR) programs.

These AAFES activities include the operation of Post Exchanges (PXs), Base Exchanges (BXs), and shoppettes (a combination convenience store and commercial vehicle fueling station), among others.

Most military installations are billed for electrical consumption and demand at a single metering point. The Directorate of Public Works (DPW) at the military installation, in turn, bills certain activities—including AAFES and Family Housing—for their respective electrical usages. On a monthly schedule, the DPW reads electrical consumption (kWh) meters located throughout these activities to bill individual activities for their usages.

Since AAFES and other activities are metered for kWh only and not actual kW demand, DPW billings reflect electrical usage based on: (1) total installation electrical costs and total consumption. This charge builds in the utility and demand charge for the entire installation, which may overcharge some users and undercharge others based on the users' ratio of consumption and demand. Whether a user is over- or undercharged depends on the characteristics of electrical usage (total consumption and peak demand) at the facility, as well as the average consumption charge versus the standard consumption and standard demand charges. This study was undertaken to determine whether there would be a significant impact if AAFES activities were billed for their actual electric consumption rather than for an average consumption.

1.2 Objective

The objective of this study was to determine the impact of billing AAFES activities based on actual electric consumption and demand, as compared to the standard practice of using an average consumption charge.

1.3 Approach

Three AAFES facilities, a PX building at Fort Hood, and PX and shoppette buildings at Fort Campbell were metered for the 1994 summer months to determine monthly electric consumption and 15-minute demand components. Two separate billings were generated from the data: (1) a billing based on an average consumption charge and, (2) a billing based on both a consumption charge and a demand charge. The two billings were compared and analyzed to determine the nature and extent of the differences between the two billing practices.

2 Description of AAFES Test Sites

2.1 Fort Hood PX

The PX (Building 50004) at Fort Hood is a large commercial building of 128,336 sq ft (1 sq ft = 0.305 m). The major electrical loads consist of two 120-ton chillers, one 125-ton chiller, air-handling equipment, and multiple fluorescent lighting loads (consistent with a large commercial building). Food service facilities such as a Baskin Robbins ice cream shop, a Burger King restaurant, and various other food vendors are also located in this building.

2.2 Fort Campbell PX

The PX (no building number) at Fort Campbell is a relatively new facility that has been in continuous operation since May 1993. The building covers 110,177 sq ft. The major electrical loads consist of two 175-ton chillers, air-handling equipment, and multiple fluorescent lighting loads (consistent with a large commercial building). Food service facilities such as a food court and a Burger King restaurant are also located in this building.

2.3 Fort Campbell Shoppette

The shoppette (Building 3000) at Fort Campbell is one of three such shoppettes on the installation. This facility is a combination convenience store and commercial vehicle fueling station. The major electrical loads are chillers for air-conditioning and refrigeration equipment for food and beverage storage.

3 AAFES Data Collection

3.1 Overview

Synergistic C-180 data acquisition devices were connected to the main panels at each AAFES test site and configured to record voltage, current, and 15-minute demand information for each of the three phases. From this data, peak kW, total kWh, and power factors could be calculated for each site. Pacific Northwest Laboratories (PNL) was contracted to collect and compile the data from each site, and to forward it to the U.S. Army Construction Engineering Research Laboratories (USACERL) for analysis.

3.2 Fort Hood PX Data Collection

Data collection at the Fort Hood PX began 16 June 1994. A Synergistic C-180 data logger was connected to both electrical panels that serve the PX. (The Appendix to this report describes the panels and kWh meter.) The installation meter was a two-circuit totalizing kWh meter of the type needed to accumulate the inputs from two electrical panels. However, researchers noted that the current transformer (CT) ratios in the two panels were different, 1000:5 on the main panel and 800:5 on the panel that served additional chiller loads. This is a significant discrepancy since this type of meter requires both inputs to have the same CT ratio. This problem was noted and brought to the attention of the Fort Hood Energy Office.

Since no phone lines were conveniently available to remotely access the data from the logger, a laptop computer was configured for data retrieval, connected to the C-180, and left on site in the mechanical room. Fort Hood Energy Office personnel were instructed how to download the data to a floppy disk to access the data and to transfer the data to USACERL.

3.3 Fort Campbell PX Data Collection

Data collection at the Fort Campbell PX began 06 June 1994. A Synergistic C-180 data logger was connected to the main electrical panel in the mechanical room. Again, locating an accessible, dedicated phone line to remotely access the logger proved

unsuccessful. Arrangements were made with a local cellular phone company to initiate a dial-in only service for the site. The antenna for the receiver was positioned outside of a vent in the mechanical room to facilitate reception.

3.4 Fort Campbell Shoppette Data Collection

Data collection at the Fort Campbell shoppette also began 06 June 1994. A Synergistic C-180 data logger was connected to an exterior electric panel that serviced the facility. Cellular phone service was also established at this site due to the difficulty in finding an accessible, dedicated phone line for remote access. The data logger was placed inside an adjacent electrical panel to shield it from outside weather conditions.

4 AAFES Data Analysis

4.1 Data Summary

Tables 1 to 3 summarize the data from the three sites. Note that some data was lost due to transmission or logger errors. The MISS.DAYS column indicates whether zero (data was complete), or 1 (24 hours), 2 (48 hours), etc. day's data were lost. The TOT kWh column lists the number of kilowatt-hours recorded for the indicated month. Below this number and denoted with an asterisk [*] is the estimated TOT kWh if there was missing data. This estimate is based on an average kWh/day obtained from the data, which was then multiplied by the number of days missing to supplement the recorded total. The MIN kW is the minimum 15-minute demand recorded for the month. The MAX kW is the maximum 15-minute demand recorded for the given month. The LD FACTOR (load factor) is the ratio of the average and the maximum 15-minute demand for the month. The load factor indicates how the demand curve deviates from the mean, or how flat the demand curve is. A perfectly flat demand curve would give a load factor of 1.0 while a demand curve with peaks that varied significantly from the mean would give a load factor much less than 1 (e.g., 0.5).

Table 1. Fort Hood PX data summary.

Month	TOT kWh[1]	MIN kW	MAX kW	LD FACTOR	MISS.DAYS
July	425,690	308	660	0.87	0
August	422,309	306	654	0.87	0
September	352,257 387,096*	406	647	0.83	2.7

[1] Measured values unless denoted with *

* Denotes estimate based on actual measured data

Table 2. Fort Campbell PX data summary.

Month	TOT kWh[1]	Min kW	Max kW	LD Factor	MISS. Days
July	415,922 429,786*	213	793	0.73	1
August	358,898 383,650*	199	830	0.62	2
September	340,145	193	770	0.61	0

[1] Measured values unless denoted with *

* Denotes estimate based on actual measured data

Table 3. Fort Campbell shoppette data summary.

Month	Tot kWh[1]	Min kW	Max kW	LD Factor	Miss. Days
July	41,745 43,185*	33	81	0.72	1
August	41,939	34	81	0.70	0
September	30,591 36,131*	35	75	0.67	4.6

[1] Measured values unless denoted with *

* Denotes estimate based on actual measured data

4.2 AAFES Meter Discrepancies

After collecting a month's data from the AAFES facilities, USACERL contacted the Energy Office at Fort Hood and the DPW at Fort Campbell to cross check the electrical consumption data being recorded by instrumentation placed at the sites for the study against the data recorded by the installations' metering equipment. It was found that the meter installed at the Fort Hood PX registered approximately one half the kWh amount being recorded by the USACERL-installed data-gathering instrumentation. When this was discovered, a site visit was made to the Fort Hood PX and a clamp-on ammeter and voltmeter were used to verify the accuracy of the measuring equipment. The manufacturer of the installed meter (General Electric [GE]) was contacted and it was learned that the two different CT ratio inputs were causing the meter to give erroneous readings. The Energy Office at Fort Hood was notified of this so that corrective action could be taken.

Historical information provided by the Budget Office in the Fort Campbell DPW indicated that the meter at the Fort Campbell PX registered approximately one-third the kWh amount being recorded by the test data-gathering instrumentation. A site visit was also made to Fort Campbell to verify the operation of the installed meter and the recording equipment. A BMI Power Profiler was connected to the main panel of the PX for 1 day. The BMI recorded both accumulated kWh and instantaneous demand. A comparison of the information from the BMI to both the installed meter at the PX and the data-recording equipment confirmed that the installed meter at the PX had been recording only about one-third of the actual kWh consumed. This inaccuracy was reported to the installation DPW.

A second trip to Fort Campbell revealed that the meter wiring diagram located in the mechanical room was inconsistent with a wiring diagram which was taken from a GE catalog. Specifically, the GE wiring diagram showed that the CT inputs on the back of the meter for one of the phases were the connected opposite to that shown in the wiring diagram in the mechanical room. All three CT inputs to the meter were subsequently shorted via a set of shorting switches under a cover on the face of the meter panel. The CT input in question was then opened and the rotating disk on the watthour meter was observed to turn backwards before it came to a halt. This reversed current flow of one of the three phases had been causing the meter to register approximately one-third of the total kWh. The CT inputs on this phase were reversed, and the disk was observed to spin in the correct direction. Subsequent monitoring of this meter indicates that it now functions accurately.

The historical kWh readings for the Fort Campbell Shoppette were consistent with the measurements obtained from the data-gathering instrumentation. Subsequently there was no reason to believe that there were inaccuracies with the data collection at this site.

4.3 Demand Profiles

Figures 1 to 18 plot the 15-minute kW demand data recorded during July and August 1994 in monthly and typical weekly demand profiles. These graphs contain a number of characteristics that imply much useful information. For example, the variation in the electrical usage during the day, week, or weekend can reveal trends attributable to specific equipment, e.g., chillers, refrigeration equipment, pumps, etc. The base load, i.e., the bottom area of the graphs that ranges from zero kW up to a kW value that is constant throughout the entire graph represents electrical loads that run constantly. These constant loads might be chillers that provide a certain level of cooling throughout the night and/or 24 hour-per-day lighting loads.

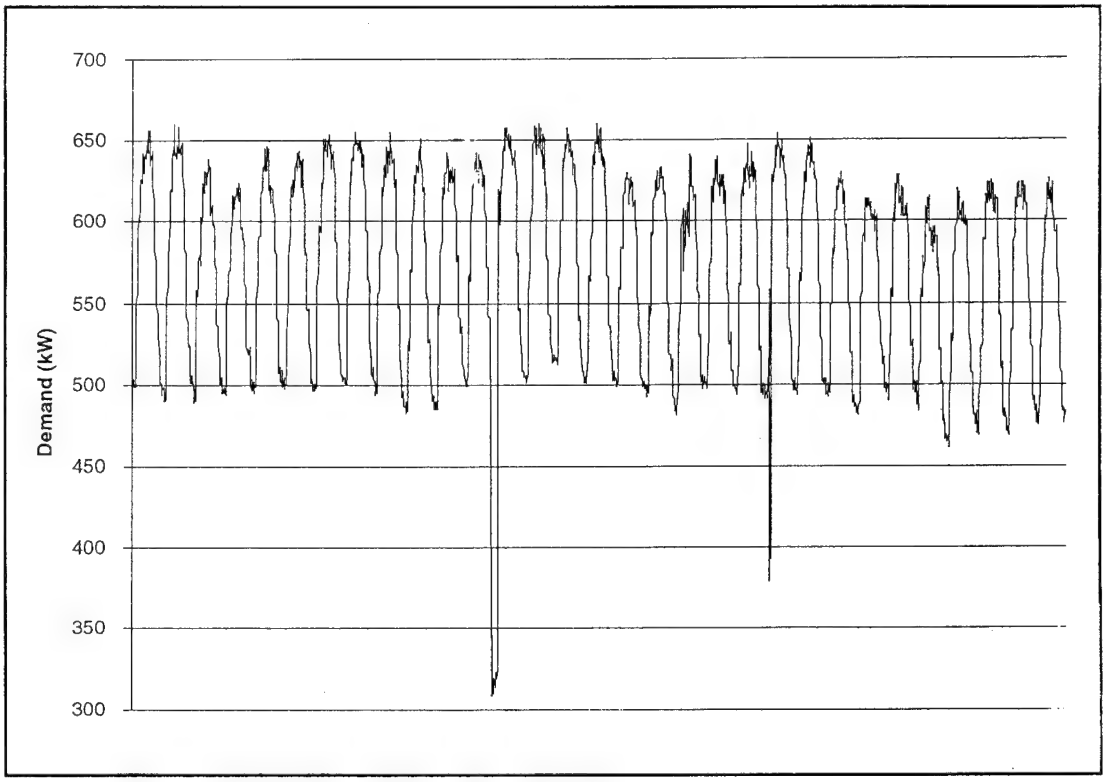


Figure 1. Fort Hood PX demand profile (1–31 July 1994).

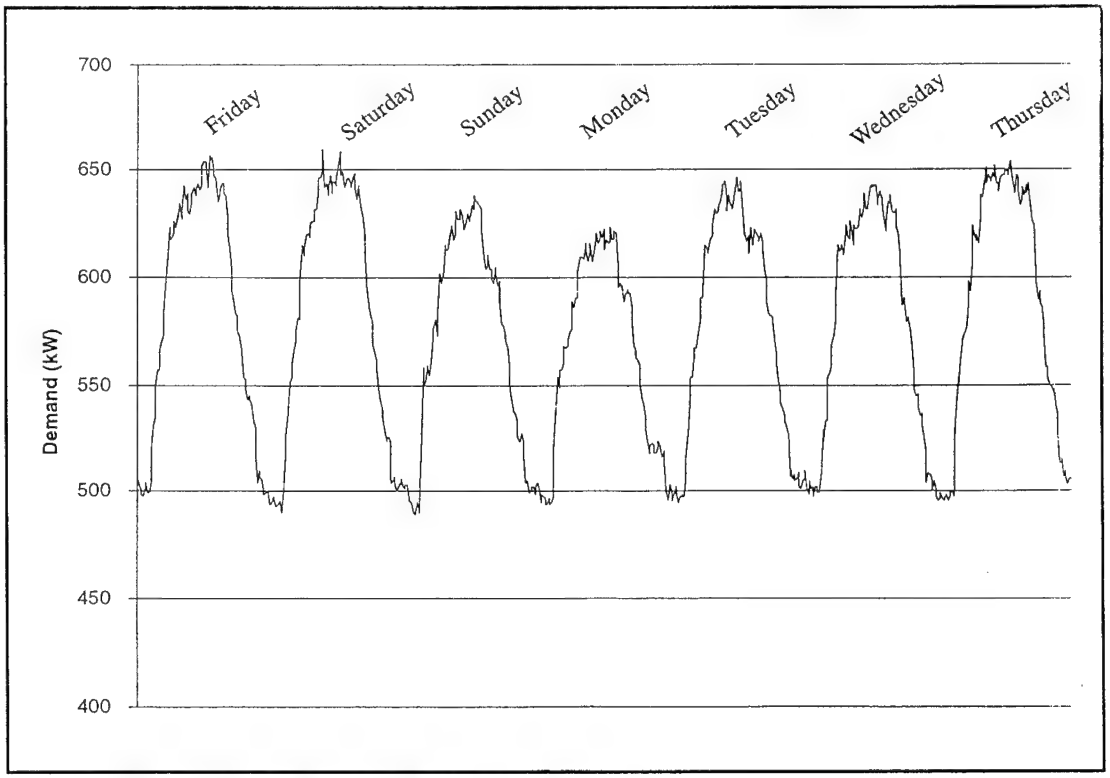


Figure 2. Fort Hood PX demand profile (1–7 July 1994).

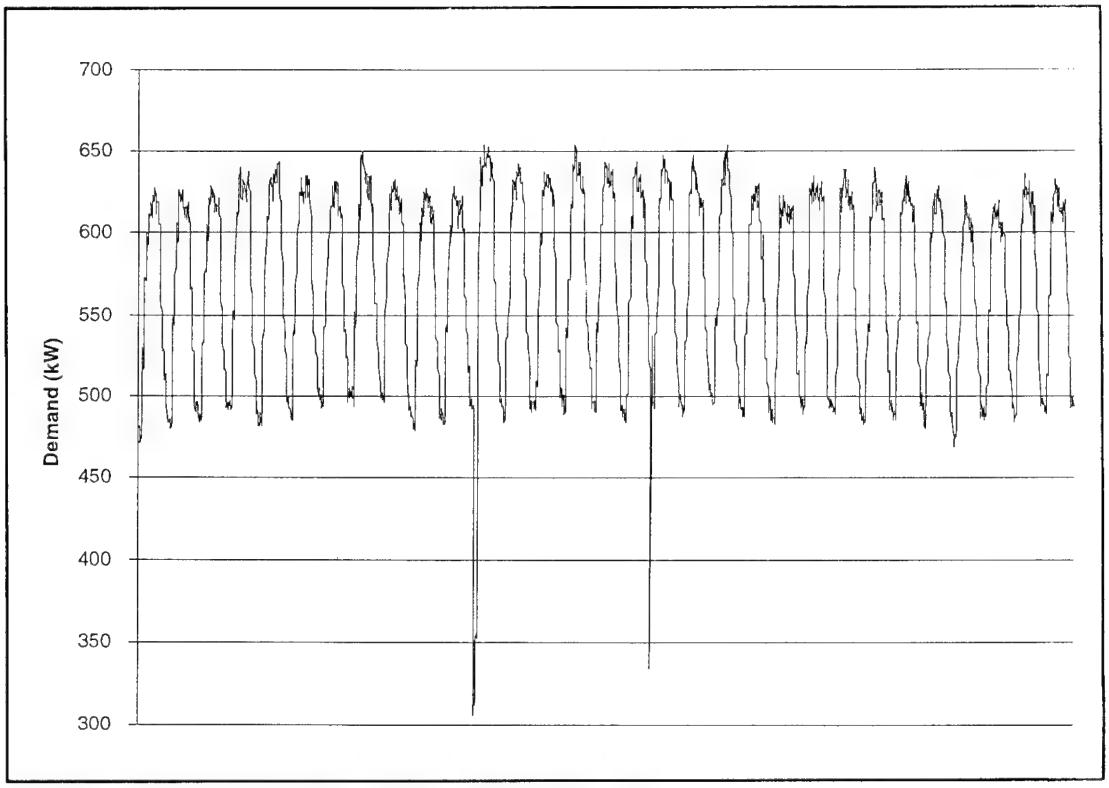


Figure 3. Fort Hood PX demand profile (1–31 August 1994).

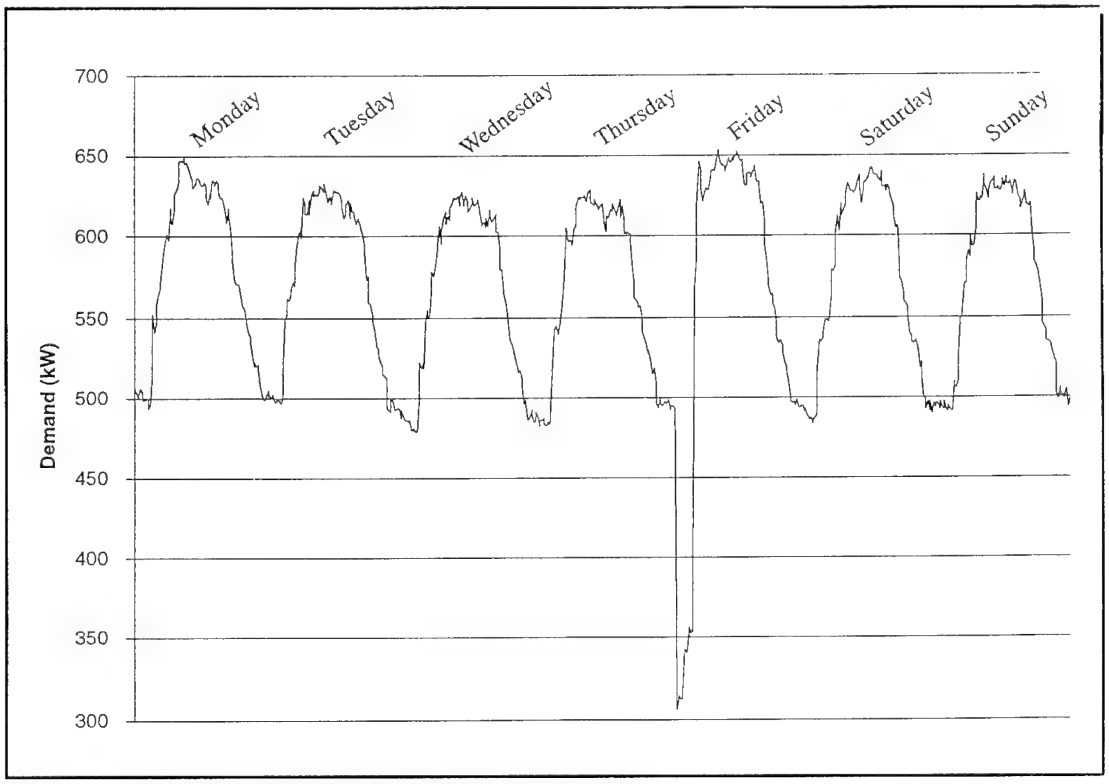
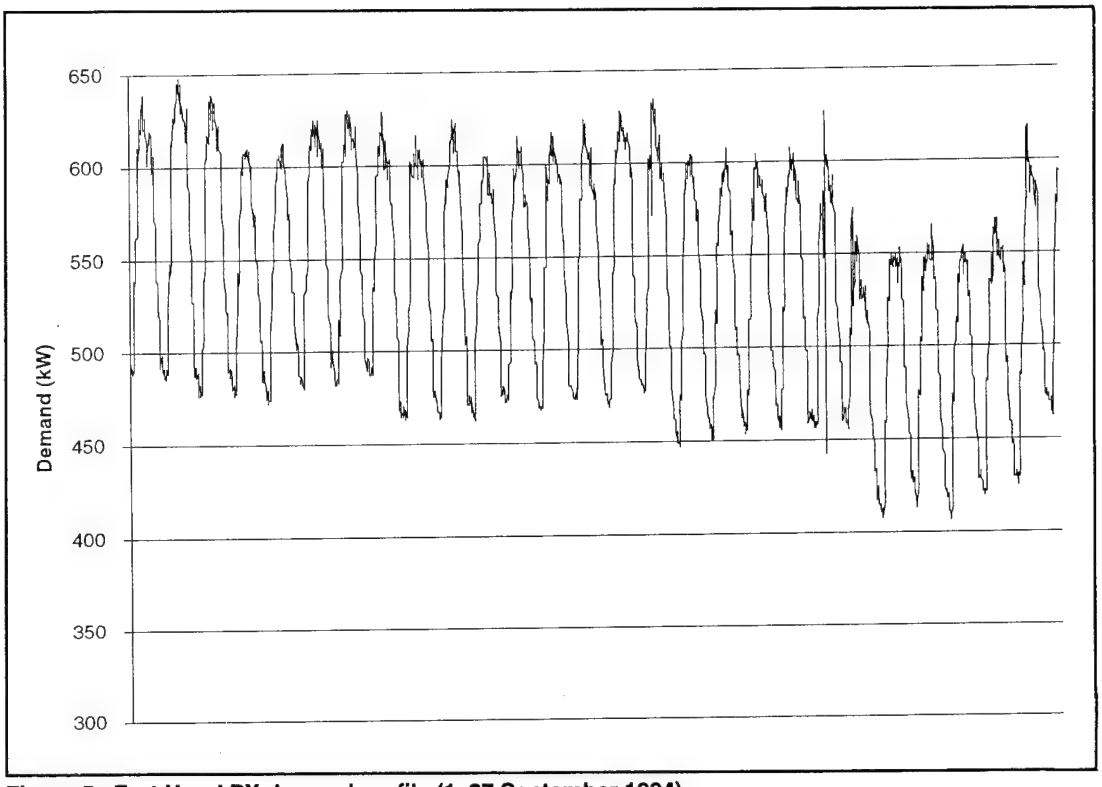


Figure 4. Fort Hood PX demand profile (8–14 August 1994).



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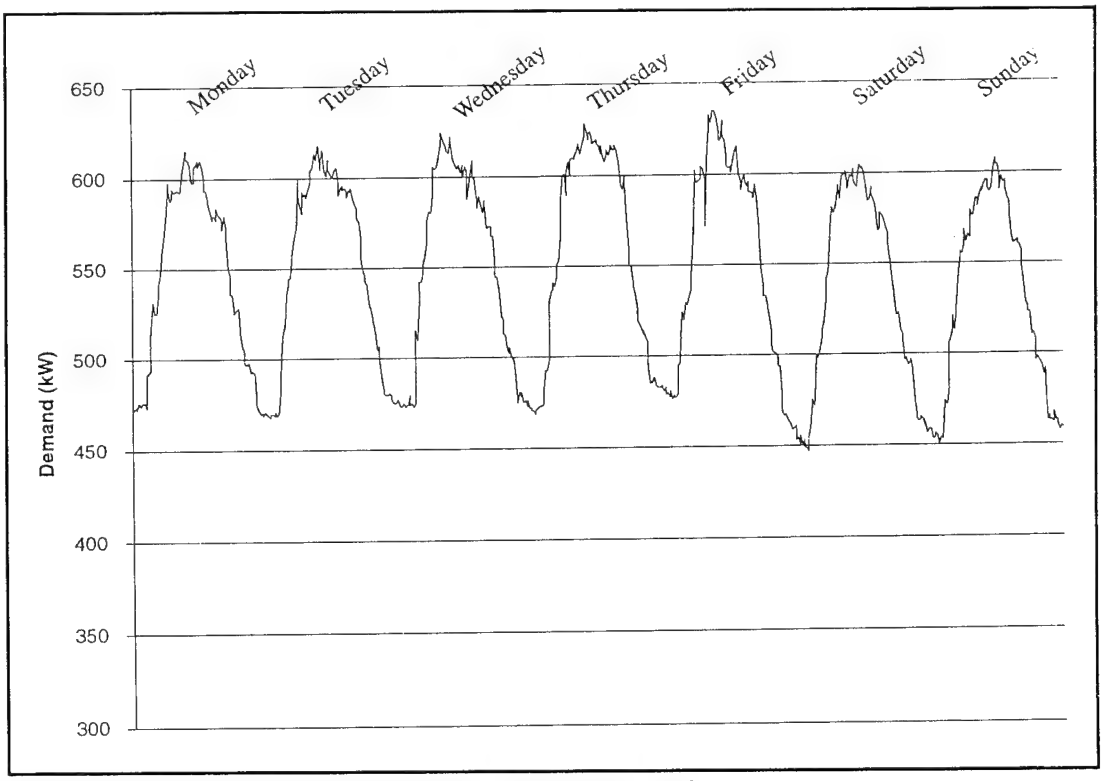

Figure 6. Fort Hood PX demand profile (12–19 September 1994).

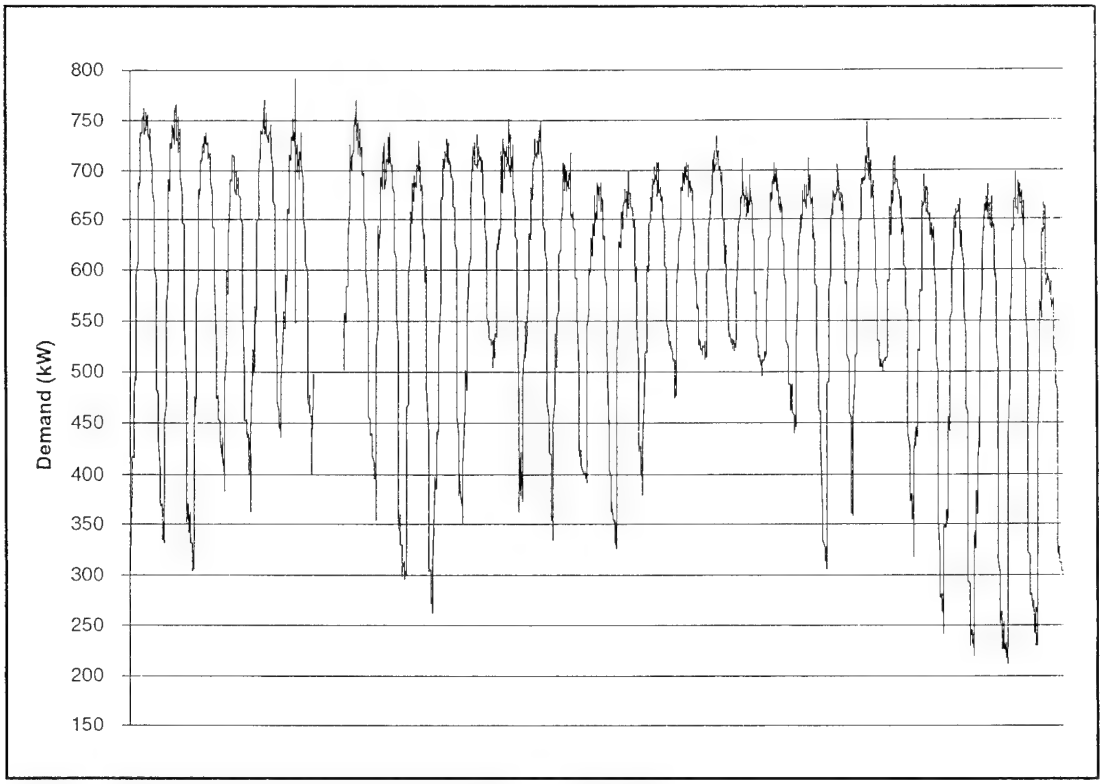

Figure 7. Fort Campbell PX demand profile (01–31 July 1994).

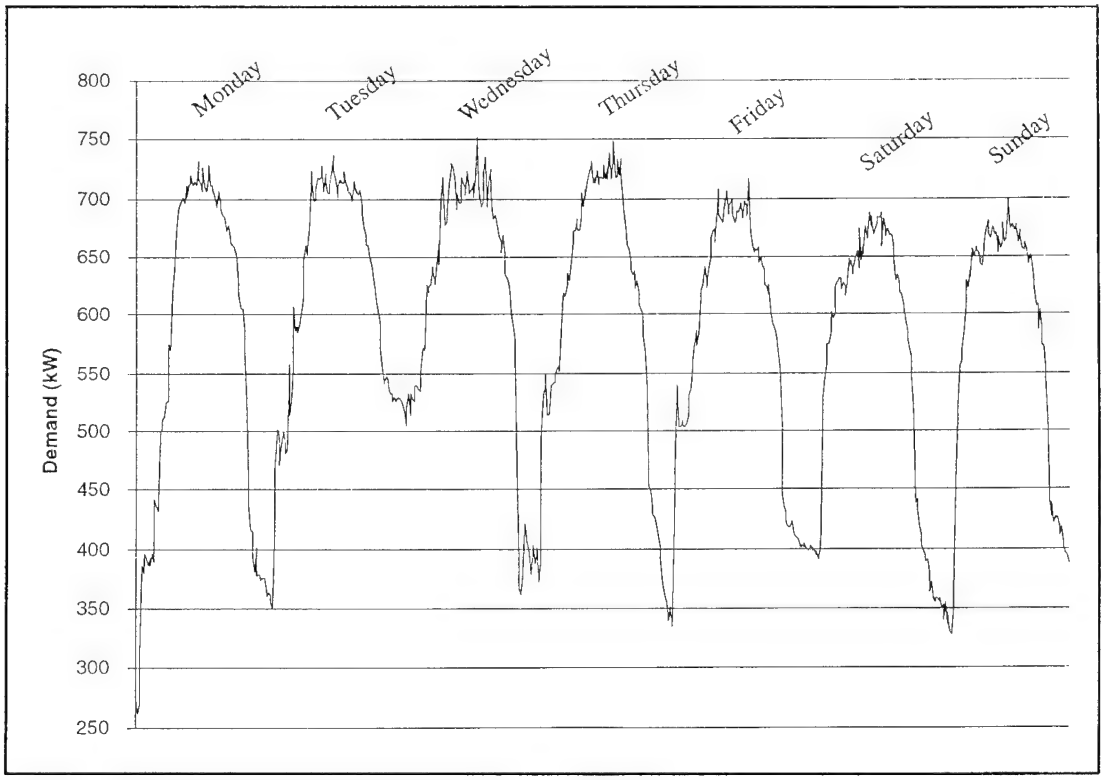

Figure 8. Fort Campbell PX demand profile (11–17 July 1994).

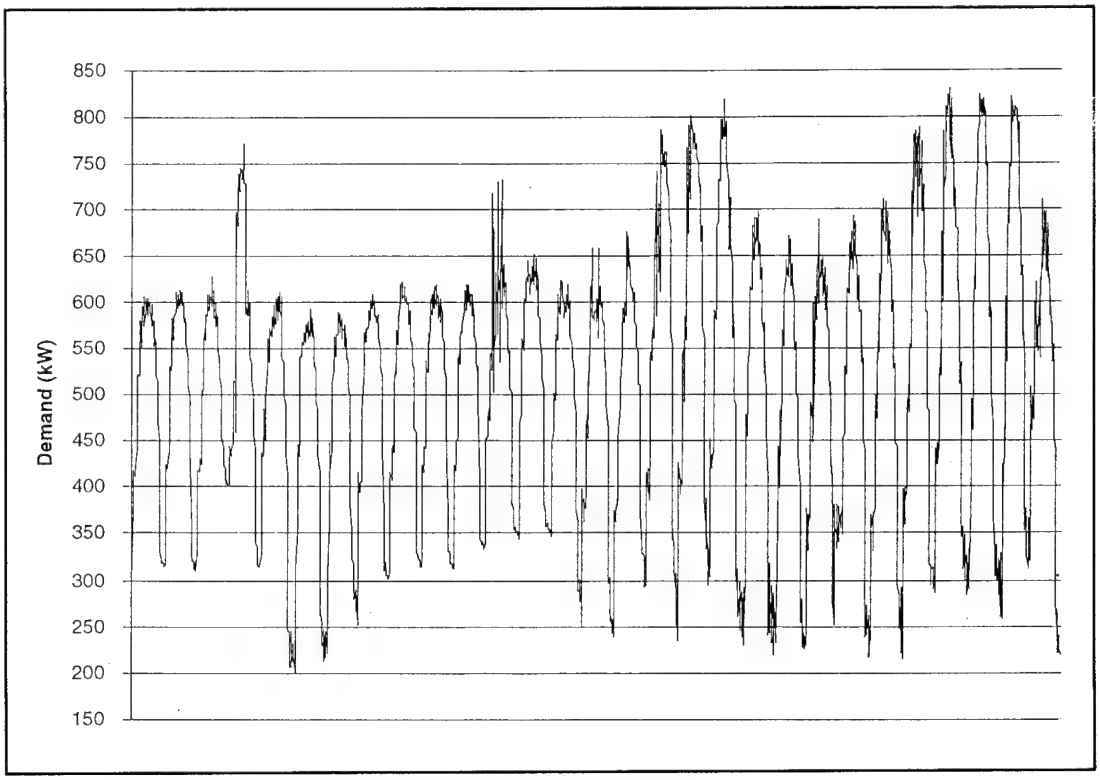

Figure 9. Fort Campbell PX demand profile (01–29 August 1994).

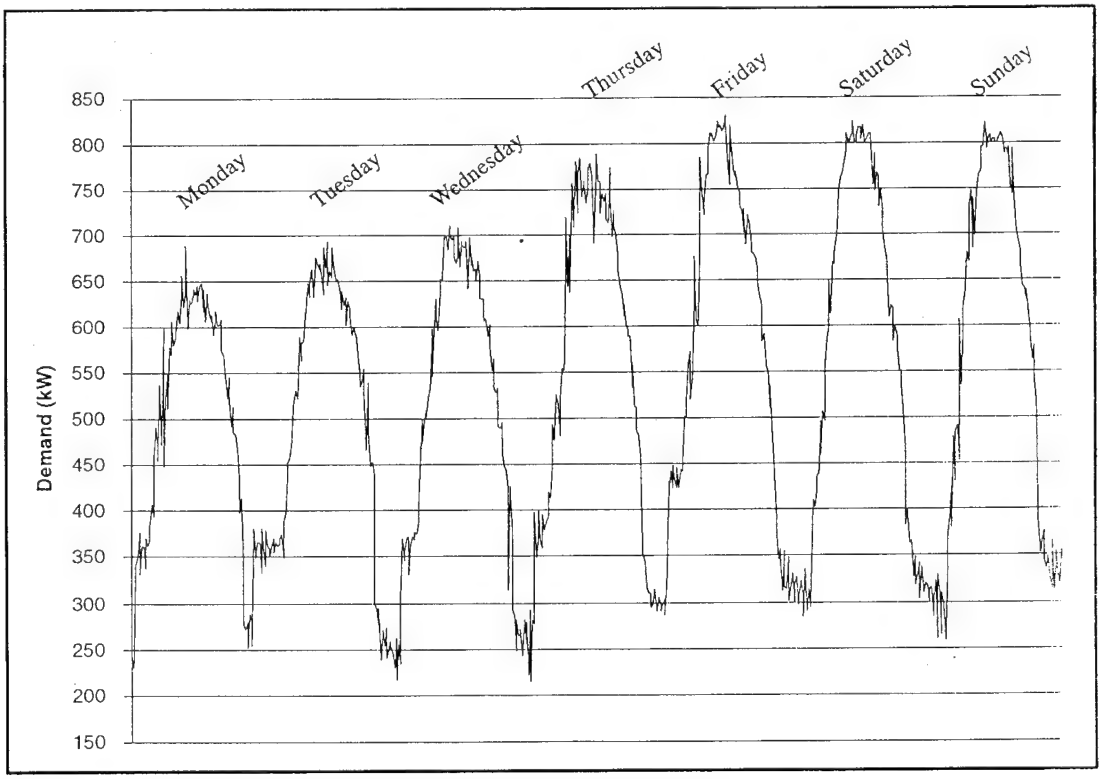

Figure 10. Fort Campbell PX demand profile (22–28 August 1994).

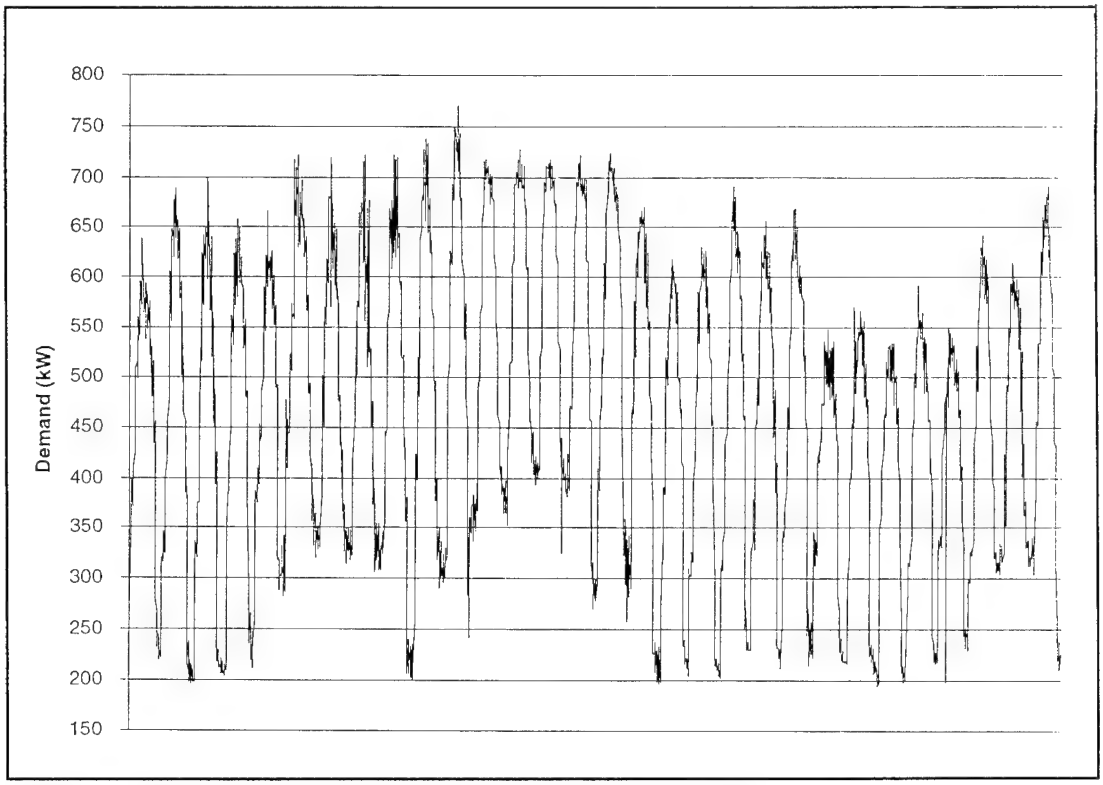

Figure 11. Fort Campbell PX demand profile (01–30 September 1994).

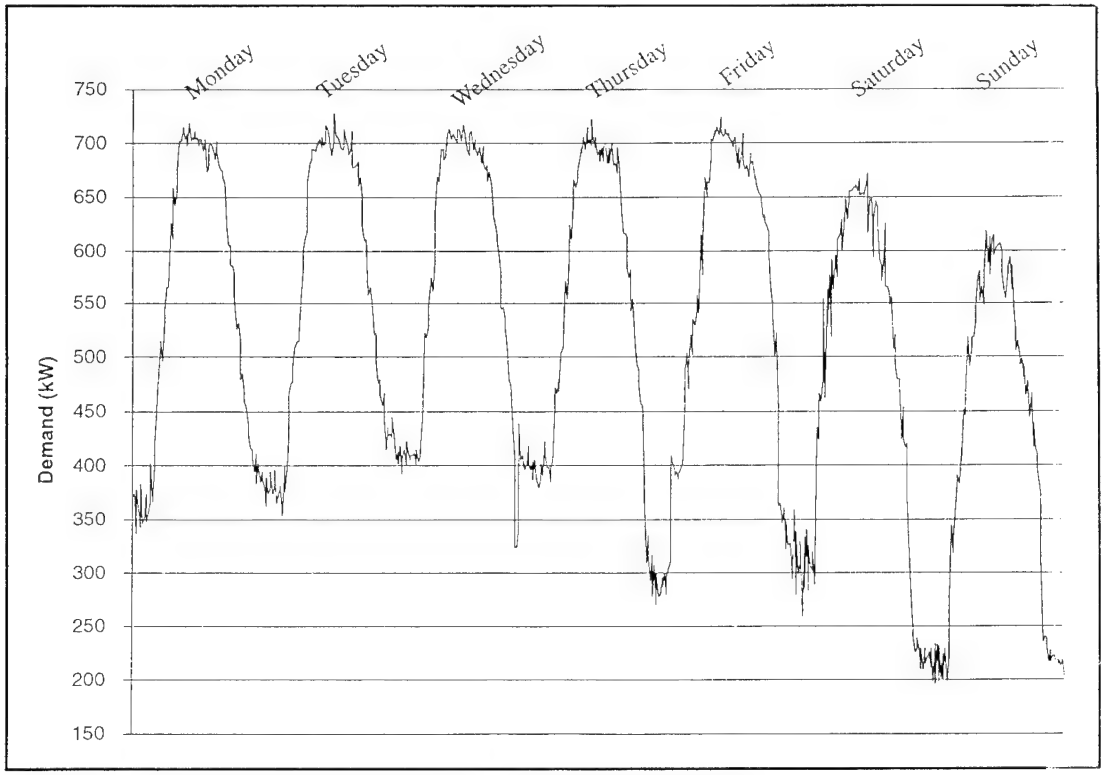

Figure 12. Fort Campbell PX demand profile (12–19 September 1994).

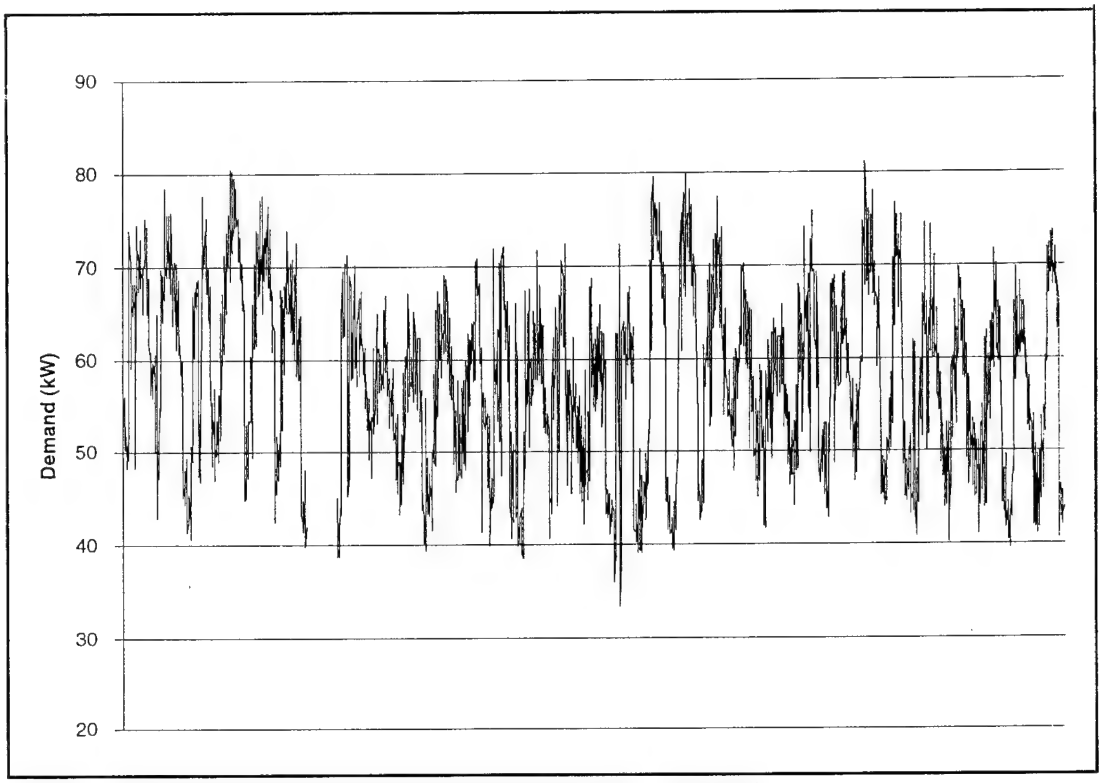

Figure 13. Fort Campbell Shoppette demand profile (01–31 July 1994).

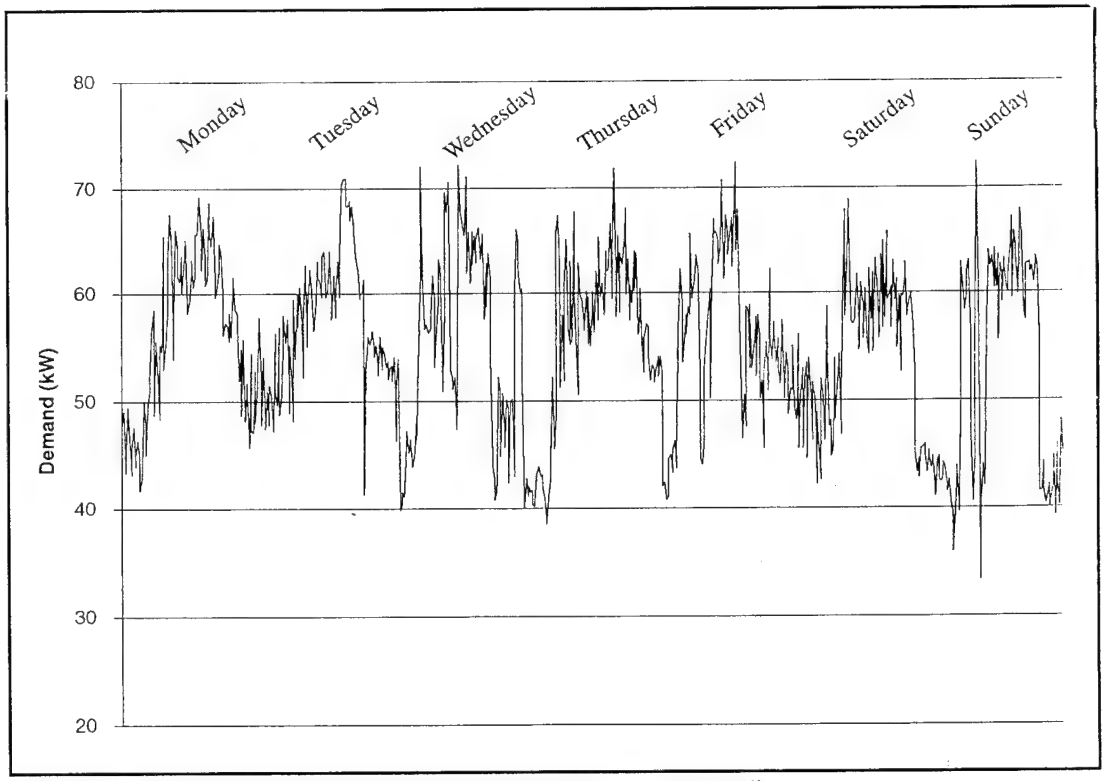

Figure 14. Fort Campbell Shoppette demand profile (11–17 July 1994).

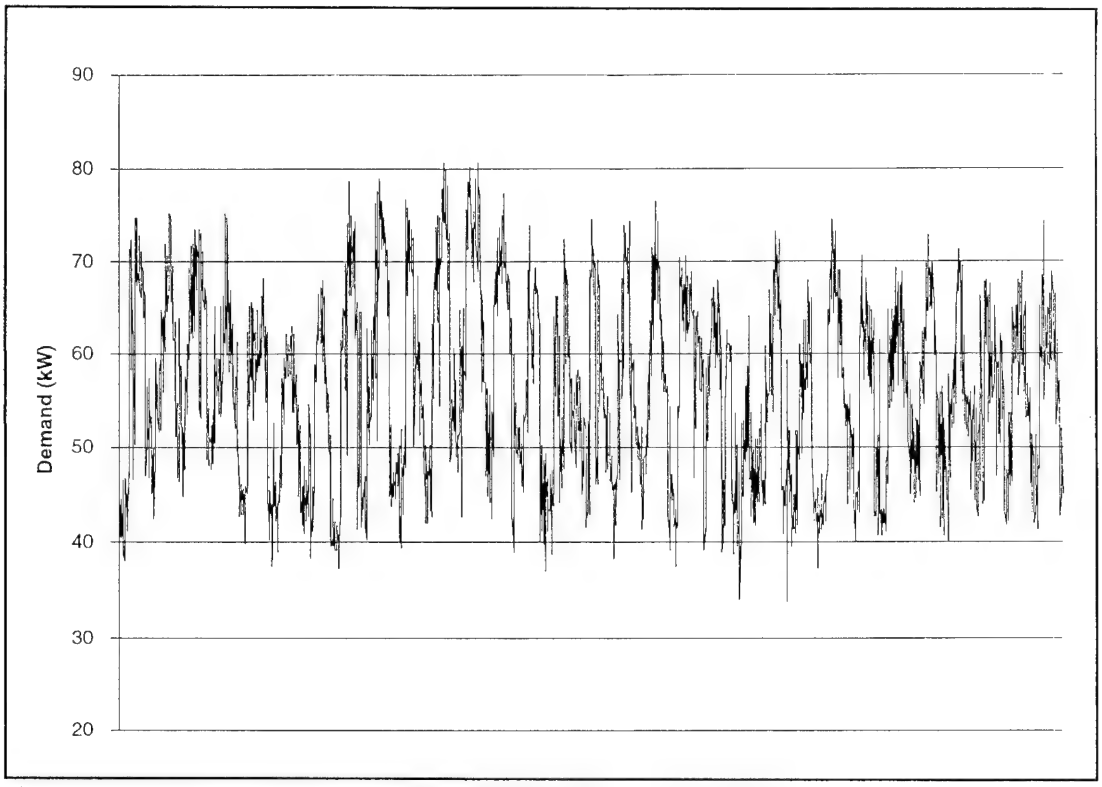

Figure 15. Fort Campbell Shoppette demand profile (01–31 August 1994).

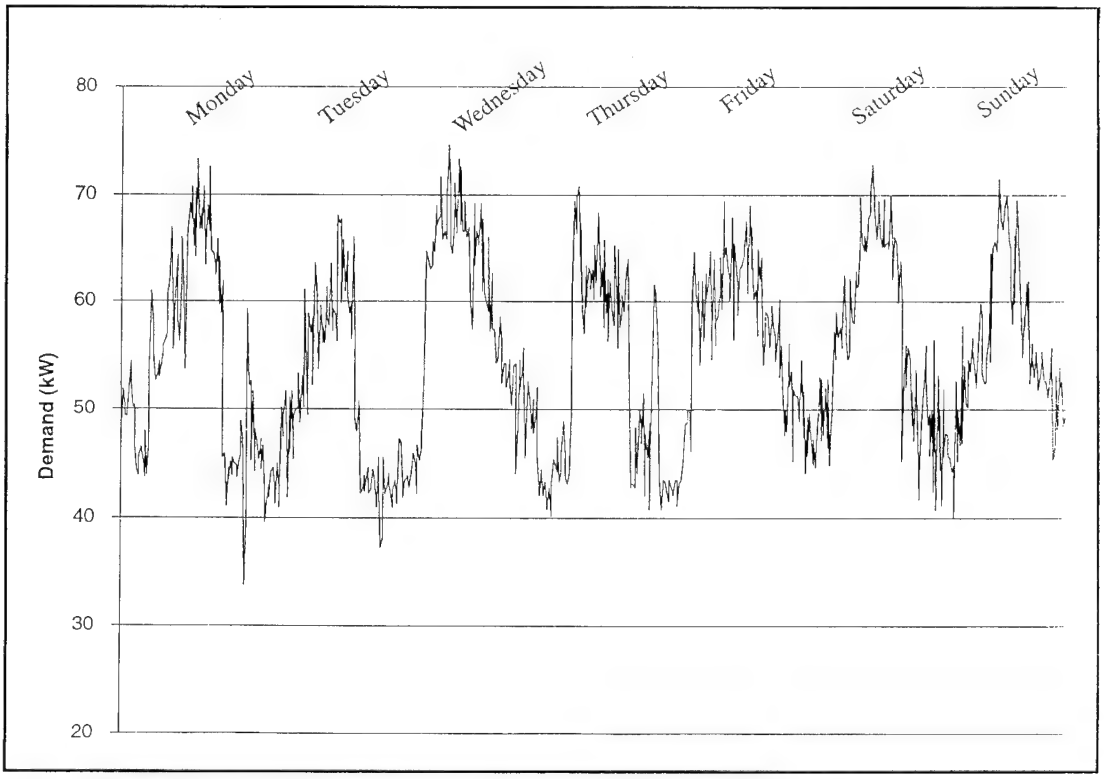

Figure 16. Fort Campbell Shoppette demand profile (22–28 August 1994).

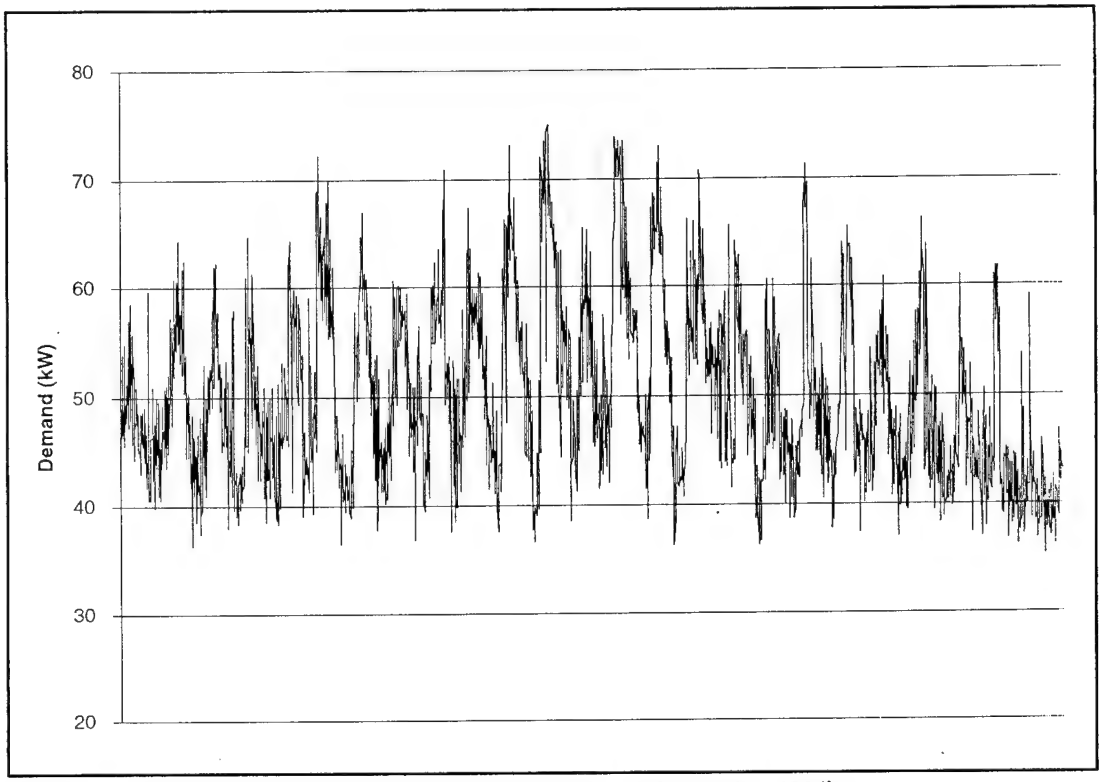

Figure 17. Fort Campbell Shoppette demand profile (01–25 September 1994).

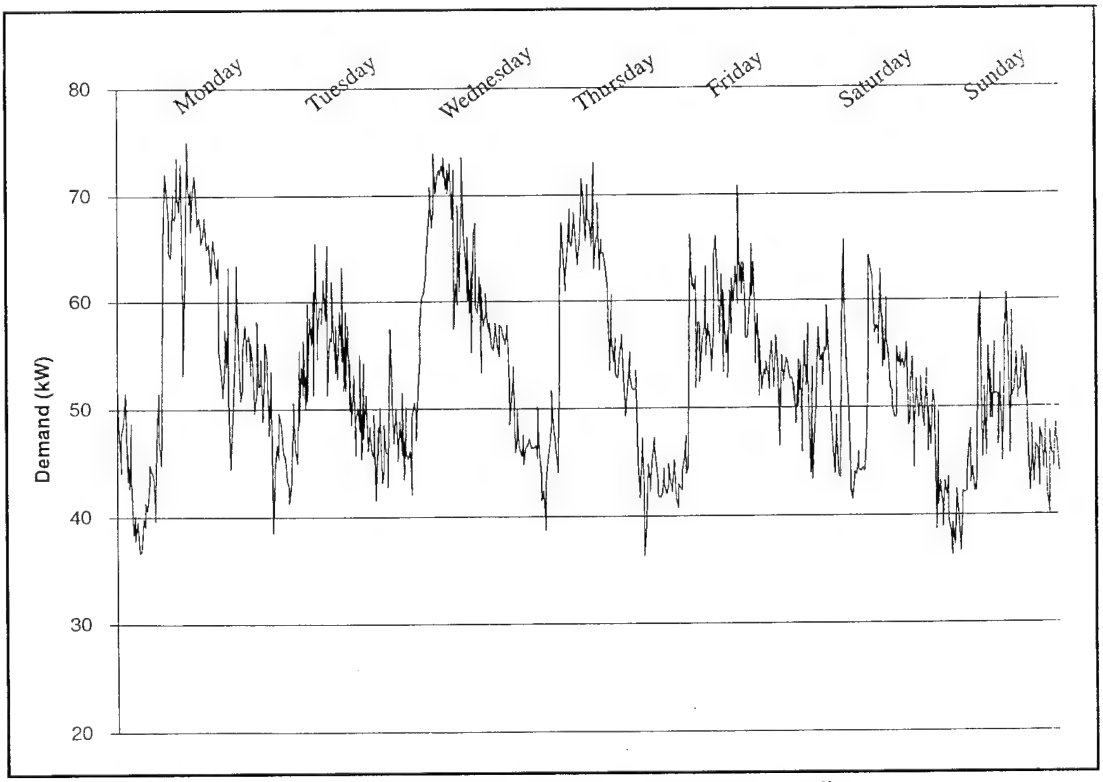

Figure 18. Fort Campbell Shoppette demand profile (12–19 September 1994).

Some of the demand profiles contain missing data. For example, data for Thursday, 7 July is missing in Figures 7 and 13. (A power outage or other anomaly apparently caused the malfunction, which is represented by a 24-hour gap in the demand curves.) In this and all other related cases, the missing data were estimated from the measured data by averaging the total kWh over the number of days actually recorded to calculate an average daily kWh value. This value was multiplied by the number of missing days and then added to the recorded total to create an estimated total.

The logger at the Fort Campbell PX also malfunctioned on both 30 and 31 August, resulting in a loss of data for those 2 days. Figure 9 shows the plot for the Fort Campbell PX for August 1994. The last 2 days of the month are truncated from the end of the plot because the loggers at the Fort Campbell Shoppette and the Fort Hood PX were removed during the last week of September resulting in a loss of 4.6 days of data from September for the Fort Campbell Shoppette and 2.7 days of data from September for the Fort Hood PX. Figures 5 and 17 have been decreased by these respective amounts.

4.4 Differences in Billing Practices

The serving electric utility company for a military installation charges the installation a fee for electrical consumption ($/kWh), and a fee for electrical demand ($/kW). The kWh charge is a true energy charge, the energy demand integrated (summed) over a fixed time period. The kW demand charge is a charge imposed on the highest (peak) energy demand during a fixed time interval (usually a 15-minute time interval). It is not uncommon for electric utility companies to use the highest peak demand on an installation as a set point for the rest of the year. For example, if the highest peak demand in the summer for a particular installation was 55 MW, then a clause in the utility contract may enable the electric utility company to base their demand fee on 80 percent of the 55 MW, or 44 MW, as the new demand for the next 11 months until this is exceeded or a new peak demand is set. This situation would be referred to as an "80 percent demand ratchet."

As discussed earlier, the DPW at the installation, in turn, bills customers such as AAFES and Family Housing for the amount of energy they use. However, the DPW uses an average kWh charge to bill for consumption as opposed to separate kWh and peak demand charges. The average kWh charge that the DPW uses is higher than the kWh charge the serving electric utility company uses because the installation is charged for both kWh usage and kW or kVA demand, along with facility charges, meter charges, and possibly power factor charges. The DPW at the installation generally analyzes these charges and incorporates them into a single kWh charge to

be applied to facilities on the installation. This way, the DPW monitors only the kWh that an AAFES or Family Housing facility uses and charges them appropriately. This method of billing negates the requirement for special demand meter instrumentation at each facility to monitor and record the highest peak demand in any 15-minute interval during the month.

The following sections compare the present practice of billing AAFES facilities based on an average kWh charge to a method of billing based on the installation-wide electric utility contract. The electric utility contract incorporates both a kWh charge and a peak demand charge. Fort Hood and Fort Campbell are served by two different utility companies, each with its own electric rate structure. Each installation will be analyzed separately account for these differences.

Demand data was collected for the summer months to determine the peak demand for the year. Since demand data was not available for the entire year, the assumption was made that the load factor (LF) for all three facilities remained constant throughout the 12 months. An average load factor was computed for each site from the load factors obtained in the summer months from the recording instruments. Historical data for kWh consumption was available for the AAFES facilities and was used in the analysis. From the load factor and historical kWh readings for the facilities, the peak kW for the months that were not recorded directly can be determined by the following equation:

$$\text{Peak kW (monthly)} = \frac{\text{Ave. kW}}{\text{LF}} = \frac{\dfrac{\text{kWh}}{\text{24 hrs.} \times \text{No. days/mo.}}}{\text{LF}} \qquad \text{[Eq 1]}$$

Since the meters at both the Fort Hood PX and Fort Campbell PX were wired incorrectly, correction factors were applied to both sets of historical kWh data to estimate the monthly consumptions.

4.4.1 Fort Hood PX Billing Comparison

4.4.1.1 Fort Hood Utility Electric Rates. The electric utility company serving Fort Hood is Texas Utilities Electric Company, based in Dallas, TX. Electric energy charges are applied in three tiers (Table 4).

Electric demand charges are $7.63 per kW of billing demand in excess of 10 kW. The billing demand is the highest recorded power during a 15-minute interval, or 80 percent of the 12-month peak, or 50 percent of the contract kW, whichever is higher. In fact, the contract kW has never been used. Consequently, the demand number used for billing is the higher of the actual monthly peak demand or 80 percent of the 12-month peak.

Table 4. Tiered electrical energy charges.

Tier	kWh Increment	Charge
Tier 1	First 2500 kWh	$0.0660/kWh *
Tier 2	Next 3500 kWh **	$0.0320/kWh *
Tier 3	All additional kWh	$0.0059/kWh *

* Additional fuel cost rider of $0.018402 and cogeneration rider of $0.000091 applies to all tiers.
** Plus an additional 215 kWh per kW of billing demand. The size of Tier 2 depends on the billing demand for the facility.

The unit kWh price is calculated from the third tier with the fuel cost rider included. The monthly kWh consumption at the Fort Hood PX is well into the third tier, so the third tier rate can be used exclusively with little error:

$$\$0.0059 + \$0.018402 \text{ (fuel cost factor)} + \$0.000091 \text{ (cogeneration cost factor)} = \$0.024393/\text{kWh}$$

The unit price for electric demand is calculated as the sum of the basic demand rate and the additional cost of shifting the electric tariff of 215 kWh from tier 2 into tier 3 for each kW of demand:

$$[\$7.63 \text{ (basic)} + 215\,\text{kW} \times (\$0.0320 - \$0.0059)] = \$13.24/\text{peak kW per month}$$

4.4.1.2 Fort Hood Energy Office Electric Billing Rates. The Energy Office at Fort Hood charges AAFES facilities a flat rate for kWh consumption. This rate is comprised of a kWh charge of $0.03738, a fuel consumption allowance charge of $0.018402, and a cogeneration charge of $0.000172 for a total rate of $0.055954/kWh.

4.4.1.3 Fort Hood PX Billing Comparison Results. Table 5 summarizes the data obtained during the summer months of 1994 and historical kWh usage provided by Fort Hood's Energy Office, using the Energy Office's average energy charge and the kWh and demand charge calculated from Texas Utilities Electric contract with Fort Hood. Note that 80 percent of the peak demand recorded during the summer ($0.8 \times 660 = 528$ kW) was used in the calculations for those months (December 1993, January 1994, and March 1994), in which the calculated peak demand fell below 528 kW (per the TU Electric 80 percent demand ratchet clause).

Table 5. Fort Hood PX billing results.

Month-Year	kWh[1]	kW Demand[2]	Energy Office Billing	Theoretical Utility Billing	Billing Difference
Oct 93	363,960	571	$20,365.02	$16,438.69	$3,926.33
Nov 93	363,960	590	$20,365.02	$16,690.71	$3,674.31
Dec 93	312,120	528†	$17,464.36	$14,604.26	$2,860.10
Jan 94	249,840	528†	$13,979.55	$13,085.07	$894.48
Feb 94	340,200	534	$19,035.55	$16,122.72	$2,912.83
Mar 94	303,480	528†	$16,980.92	$14,393.51	$2,587.41
Apr 94	410,760	666	$22,983.67	$18,836.89	$4,146.77
May 94	385,560	605	$21,573.62	$17,414.28	$4,159.35
Jun 94	331,920	538	$18,572.25	$15,221.40	$3,350.86
Jul 94	425,690*	660*	$23,819.06	$19,122.26	$4,696.80
Aug 94	422,309*	654*	$23,629.88	$18,960.34	$4,669.53
Sep 94	387,096*	647*	$21,659.57	$18,008.71	$3,650.86
Totals:	4,296,895	7,049	$240,428.46	$198,141.64	$41,529.64

1 Estimated from historical data unless denoted with *
2 Estimated from historical data and measured load factor unless denoted with * or †
* Based on actual measured data
† 80 percent peak demand ratchet

4.4.2 Fort Campbell PX Billing Comparison

4.4.2.1 Fort Campbell Utility Electric Rates. The electric utility company serving Fort Campbell is the Tennessee Valley Authority (TVA), based in Memphis, TN. The TVA's energy consumption charge is not tiered; rather it is fixed at $0.02114/kWh. Other charges include a $1500 per delivery point per month, which is a one-time charge per month for the entire installation, and a reactive demand charge for lagging kVAR (basically a charge for poor power factor). Neither of these two charges was included in the analysis of Fort Campbell's AAFES facilities.

The TVA has a base demand charge of $11.78 per kW of billing demand per month plus an additional $11.78 per kW per month for each kW of the amount by which Fort Campbell's demand exceeds the contract demand. The contract demand for Fort Campbell is currently set to 52,000 kW. Historical data records dated back to August of 1993 show that this contract demand figure has never been met or exceeded.

Demand is determined as follows. The metered demand for any month shall be the highest average during any 30 consecutive minute interval during the month, and such

demand shall be used as the billing demand, except that the billing demand for any month shall in no case be less than the sum of: (1) 30 percent of the first 5,000 kW, (2) 40 percent of the next 20,000 kW, (3) 50 percent of the next 25,000 kW, (4) 60 percent of the next 50,000 kW, (5) 70 percent of the next 100,000 kW, (6) 80 percent of the next 150,000 kW, and (7) 85 percent of all kW in excess of 350,000 kW of the higher of the currently effective contract demand and the highest billing demand established during the preceding 12 months.

Since the contract demand is equal to 52,000 kW for Fort Campbell, the ratchet demand is then equal to:

5,000	×	0.30	=	1,500 kW
20,000	×	0.40	=	8,000 kW
25,000	×	0.50	=	12,500 kW
2,000	×	0.60	=	1,200 kW
Total ratchet demand			=	23,200 kW

Historical data obtained from Fort Campbell dating back to August 1993 indicates that the total demand for the month never decreased below the ratchet demand. In other words, the billing demand for Fort Campbell has been equal to the actual monthly demand since August 1993, and presumably earlier.

4.4.2.2 Fort Campbell DPW Electric Billing Rates. The DPW at Fort Campbell charges AAFES facilities a flat rate for kWh consumption equal to $0.0515/kWh. However, starting in April 1994, the rate decreased to $0.0488/kWh. This lower rate was used in the analysis for the subsequent months.

4.4.3 Fort Campbell PX Billing Comparison Results

Table 6 summarizes the data obtained during the summer months of 1994, and historical kWh usage provided by the Fort Campbell DPW, using the DPW's average energy charge and the kWh and demand charge calculated from the TVA contract with Fort Campbell.

Table 6. Fort Campbell PX billing results.

Month-Year	kWh[1]	kW Demand[2]	Energy Office Billing	Theoretical Utility Billing	Billing Difference
Oct 93	276,480	569	$14,238.72	$12,545.20	$1,693.52
Nov 93	302,400	643	$15,573.60	$13,965.59	$1,608.01
Dec 93	224,640	462	$11,568.96	$10,192.97	$1,375.99
Jan 94	224,640	462	$11,568.96	$10,192.97	$1,375.99
Feb 94	138,240	315	$7,119.36	$6,631.55	$487.81
Mar 94	282,240	581	$14,535.36	$12,806.55	$1,728.81
Apr 94	239,040	508	$11,665.15	$11,039.47	$625.68
May 94	285,120	587	$13,913.86	$12,937.23	$976.62
Jun 94	319,680	680	$15,600.38	$14,763.63	$836.76
Jul 94	429,786*	793*	$20,973.56	$18,427.22	$2,546.34
Aug 94	383,650*	830*	$18,722.12	$17,887.76	$834.36
Sep 94	340,145*	770*	$16,599.08	$16,261.27	$337.81
Totals	3,446,061	7,199	$172,079.10	$157,651.40	$14,427.70

1 Estimated from historical data unless denoted with *
2 Estimated from historical data and measured load factor unless denoted with *
* Based on actual measured data

4.4.4 Campbell Shoppette Billing Comparison Results

Table 7 summarizes the data obtained during the summer months of 1994 and historical kWh usage provided by the Fort Campbell DPW, using the DPW's average energy charge and the kWh and average demand charge calculated from the TVA contract with Fort Campbell.

Table 7. Fort Campbell shoppette billing results.

Month-Year	kWh[1]	kW Demand[2]	Energy Office Billing	Theoretical Utility Billing	Billing Difference
Oct 93	31,680	61	$1,631.52	$1,389.72	$241.80
Nov 93	31,320	62	$1,612.98	$1,397.65	$215.33
Dec 93	24,240	47	$1,248.36	$1,063.34	$185.02
Jan 94	24,240	47	$1,248.36	$1,063.34	$185.02
Feb 94	27,120	52	$1,396.68	$1,255.72	$140.96
Mar 94	24,000	46	$1,236.00	$1,052.81	$183.19
Apr 94	28,440	57	$1,387.87	$1,269.13	$118.74
May 94	30,720	59	$1,499.14	$1,347.60	$151.53
Jun 94	31,320	62	$1,528.42	$1,397.65	$130.77
Jul 94	43,185*	81*	$2,107.43	$1,867.11	$240.32
Aug 94	41,939*	81*	$2,046.62	$1,840.77	$205.85
Sep 94	36,131*	75*	$1,763.19	$1,647.31	$115.88
Totals	374,335	737	$18,706.57	$16,592.16	$2,114.41

1 Correct historical data unless denoted with *
2 Estimated from historical data and measured load factor unless denoted with *
* Based on actual measured data

5 Conclusions

This study compared the impact on three AAFES facilities (The Fort Hood PX, the Fort Campbell PX, and a Fort Campbell shoppette) of billing electric usage based on actual consumption and demand, as opposed to the standard practice of using an average consumption charge. In all three cases, the use of an average consumption charge gave higher annual totals for electrical usage than the calculated annual totals for billing based on separate consumption and demand charges. Specifically, billing by the present practice (of using an average consumption charge) gave the following higher annual charges:

- Fort Hood PX: $41,529.64 higher
- Fort Campbell PX: $14,427.70 higher
- Fort Campbell Shoppette: $2,114.41 higher.

These results indicate that AAFES facilities may benefit from a utility company style of billing, in which users pay based on actual consumption (kWh) and demand (kW).

There is a caveat to this statement. A change in billing procedures from a charge based on a calculated average consumption charge to one based on actual consumption and demand, would incur additional costs not addressed in this analysis. Such costs would include the purchase, installation, and maintenance of demand metering instrumentation, and expenditures associated with increased personnel time for meter reading, billing preparation, etc., for each AAFES facility.

This analysis is based on many assumptions. Since the demand profiles for much of the year were unknown, the monthly demand for unrecorded months were estimated from an average load factor and historical kWh readings. Historical kWh readings from both the Fort Hood PX and the Fort Campbell PX were in turn estimated from actual readings that were skewed by factors of approximately 1.8 and 3.0, respectively, because of wiring problems at the installations' meters. However, since the assumptions were based on historical data and trends, and supplemented by practical engineering judgement, it is concluded that the results of this analysis are still credible and relate the correct trend of the data.

The results of this report are based on current electric utility pricing structures. There appears to be a trend in the electric utility industry to bill customers based on Time of Use (TOU) rates. In this billing structure, customers are billed for electrical usage (kWh) based on the time of day that use occurred. For example, a customer may be charged $0.03/kWh between the hours of midnight and 11 a.m. and charged $0.08/kWh between the hours of 11 a.m. and 7 p.m. If AAFES decided to switch to a utility style billing and TOU rates were initiated sometime in the future, subsequent electrical billing of AAFES facilities by the DPW would be affected accordingly. Depending on the specific TOU rate structure and charges, AAFES facilities may be charged more or less for electrical usage as they were before this type of structure was imposed.

If the electrical billing practice for AAFES facilities is changed to incorporate a utility style billing, it is recommended that installation DPWs employ electrical demand and/or kWh consumption meters with automated data collection capabilities at each AAFES facility under their management. If properly implemented and maintained, this action will greatly reduce the time required for meter reading and billing preparation.

Finally, an important finding of this analysis and study was that of the malfunction of the installation electrical meters at two of the three AAFES sites monitored. Since the malfunction of two of three meters at AAFES facilities selected at random is significant, it is recommended that a historical survey of electrical usage data be conducted for AAFES facilities. Survey results could be combined with kWh/square footage numbers for each facility to compare metered values with realistic expectations based on calculation, given the function of the facility and the climate at its location. Site visits and investigations should be performed at any facility where historical data is inconsistent with the results of this analysis and comparison.

Appendix: Meter Descriptions

Fort Hood PX Meter

The master electric meter at the Fort Hood PX is a GE, panel mount, model DSM-69, 240 Volt, kilowatt-hour meter with a demand register. This meter is connected to both the main 480/277 volt wye service with 1000:5 amp current transformers (CTs) and a service panel via 800:5 CTs, which serves additional chiller loads. The multiplier used for this meter is 200. That is, for every whole increment registered on this meter, an equivalent of 200 kWh has been consumed by the PX. This meter is read monthly by Fort Hood Energy Office personnel for billing purposes.

Fort Campbell PX Meter

The master electric meter at the Fort Campbell PX is a GE, panel mount, model DSMW-64, 120 Volt, kilowatt-hour meter with a demand register. This meter is connected to the main 480/277 volt wye service with 2.4:1 voltage transformers (VTs) and 2000:5 amp CTs. The multiplier for this meter is equal to the VT ratio times the CT ratio, or, 2.4 x 400 = 960. That is, for every whole increment registered on this meter, an equivalent of 960 kWh has been consumed by the PX. This meter is read monthly by DPW personnel for billing purposes.

Fort Campbell Shoppette Meter

The master electric meter at the Fort Campbell Shoppette is a GE, socket mount, model V-64S, 120 Volt, kilowatt-hour meter. This meter is connected to the main 208/120 volt wye service with 600:5 amp CTs. The multiplier for this meter is equal to the CT ratio, or, 120. That is, for every whole increment registered on this meter, an equivalent of 120 kWh has been consumed by the shoppette. This meter is read monthly by DPW personnel for billing purposes.

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